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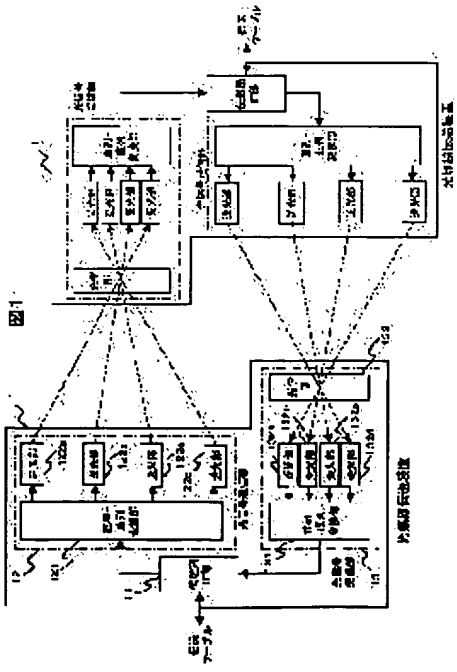
(54) OPTICAL WIRELESS TRANSMITTING SYSTEM AND OPTICAL WIRELESS TRANSMITTING METHOD



(57)Abstract:

PROBLEM TO BE SOLVED: To realize the high speed optical wireless transmission not slower than the followup speed which a light emitting element has.

SOLUTION: In an optical signal transmitting part 12, communication data is divided into multiple pieces of division data and they are converted into optical signals which are not coherent. The signals are transmitted from a plurality of light transmission units 122a to 122d in parallel. In an optical signal receiving unit 13, the optical signals which are transmitted in parallel from the optical wireless transmitter 1 of a communication opposite part are received and are converted into division data by using an optical unit 133 and a plurality of light receiving units 132a to 132d respectively corresponding to a plurality of light transmitting units 122a to 122d which the optical wireless transmitter 1 of the communication opposite party has one to one. Data are multiplexed and communication data is restored. A plurality of light receiving units 132a to 132d are arranged so that the spots of the light transmission signals of the corresponding light transmission units 122a to

122d are positioned on the light receiving plance.

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CLAIMS

[Claim(s)]

[Claim 1] It is an optical radio-transmission system containing the lightwave signal sending set which changes and carries out light transmission of the commo data to a lightwave signal, and the lightwave signal receiving set which receives a lightwave signal and is changed into commo data. Said lightwave signal sending set Provide a luminescence means to send out the light which is not coherent, and said luminescence means is driven. Two or more emitter parts which carry out light transmission of the lightwave signal according to the inputted data, and commo data are divided into the commo data for the number of said emitter part (it is called division data). It has the serial-parallel transducer which carries out a parallel transmission to said two or more emitter parts. Said lightwave signal receiving set Said two or more emitter parts and two or more light sensing portions which counter by 1 to 1 which possess a light-receiving means and output the division data according to the lightwave signal which received light with said light-receiving means, The juxtaposition-serial transducer which carries out multiplex [of the division data by which the juxtaposition output was carried out from said two or more light sensing portions], and restores said commo data, It has the optical department which

condenses each of the lightwave signal by which juxtaposition light transmission was carried out from said lightwave signal sending set. Said optical department The optical radio-transmission system by which the spot of the light transmission signal of said emitter part which counters is characterized by being constituted about each of two or more of said light sensing portions so that it may be formed on the light-receiving side of said light-receiving means which said light sensing portion possesses.

[Claim 2] It is the optical radio-transmission system which is an optical radio-transmission system according to claim 1, and is characterized by said optical department being one optical system.

[Claim 3] It is the optical radio-transmission system characterized by being an optical radio-transmission system according to claim 2, for said luminescence means being LED, and said optical department consisting of convex lenses.

[Claim 4] It is an optical radio-transmission system according to claim 1, 2, or 3. Said light-receiving means The control means which turns on and off two or more photo detectors arranged on the light-receiving side and said two or more photo detectors of each is provided. Said control means The optical radio-transmission system characterized by detecting the ratio to a different frequency component from said lightwave signal included in said light-receiving signal, and said lightwave signal included in said light-receiving signal of the same frequency component, and said ratio turning off said photo detector of under a predetermined value about said two or more photo detectors of each.

[Claim 5] A lightwave signal sending set according to claim 1, 2, 3, or 4.

[Claim 6] A lightwave signal receiving set according to claim 1, 2, 3, or 4.

[Claim 7] The lightwave signal sending set according to claim 1, 2, 3, or 4 for being optical radio-transmission equipment which performs optical radio among one pair of optical radio-transmission equipments, and carrying out light transmission of the commo data to said optical radio-transmission equipment which changes and counters a lightwave signal, Optical radio-transmission equipment characterized by having a lightwave signal receiving set according to claim 1, 2, 3, or 4 for receiving the lightwave signal by which light transmission was carried out from said optical radio-transmission equipment which counters, and changing into commo data.

[Claim 8] It is the optical radio-transmission approach using the lightwave signal sending set which changes and carries out light transmission of the commo data to a lightwave signal, and the lightwave signal receiving set which receives a lightwave signal and is changed into commo data. Said lightwave signal sending set Divide commo data into two or more commo data (it is called division data), and each is changed into the lightwave signal formed with the light which is not coherent. Processing which carries out juxtaposition light transmission of these from two or more emitter parts is performed. Said lightwave signal receiving set Said spot of the light transmission signal of said emitter part which counters which counters by two or more emitter parts and 1 to 1, and is formed of optical system The optical radio-transmission approach which receives each of said lightwave signal by which juxtaposition light transmission was carried out, changes into division data using two or more light sensing portions arranged so that it may be located on a light-receiving side, carries out multiplex [of these], and is characterized by performing processing which restores said commo data.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the technique of performing a radio transmission using a lightwave signal.
[0002]
[Description of the Prior Art] Conventionally, the optical radio-transmission system which performs a radio transmission using a lightwave signal is used for transmission of commo data between the points where construction of the transmission media for example, between buildings etc. is difficult. Generally, an optical radio-transmission system consists of one pair of optical radio-transmission equipments with which each was equipped with the emitter part and the light sensing portion. And the radio transmission of the commo data is carried out by sending and receiving the lightwave signal acquired in modulating commo data among one pair of these optical radio-transmission equipments.
[0003]
[Problem(s) to be Solved by the Invention] In an optical radio-transmission system which was mentioned above, the high-speed radio transmission was realized by using laser equipment with a quick imitation rate (on-off change rate) for an emitter part conventionally. However, laser equipment has a fault, such as "a life is "expensive" and short" and "a control system becoming complicated", and if laser equipment is used for an emitter part, the cost (product cost, maintenance / employment cost) of an optical radio-transmission system will become high. For this reason, for example compared with laser equipments, such as LED (Light Emitting Diode), although an imitation rate is slow, it is cheap and an emitter part is expected to realize a high-speed radio transmission using a light emitting device with easy control.
[0004] Here, there are multi-level modulation methods, such as a wavelength division multiplex (WDM) method, and QPSK (Quadrature Phase Shift Keying), QAM (Quadrature Amplitude Modulation), as a technique for realizing the high-speed radio transmission more than the imitation rate which a light emitting device has. However, if it is cheap compared with laser equipments, such as LED, and control applies these techniques to the optical radio-transmission system which used the easy light emitting device for the emitter part, the following problems will arise.
[0005] That is, in wavelength division multiplexing, the light emitting device which carries out light transmission of the light of mutually different wavelength is [two or more] necessary. However, it is difficult to have the radiant flux strength property of extent which can be used for the optical wireless between the about dozens of m [several m -] away points, for example, and for properties other than light transmission wavelength to receive two or more equivalent LED as a general-purpose article cheaply that is,. It learns, if a special order is not given to the manufacture manufacturer of LED etc. in order for properties other than light transmission wavelength to prepare two or more equivalent LED, if it resays, and it is **. Generally such LED is expensive compared with a general-purpose article. Moreover, the light filter for separating the lightwave

signal by which the wavelength division multiplex was carried out is needed. For this reason, the optical system by the side of a light sensing portion becomes complicated and expensive. Therefore, even if it uses LED for an emitter part, in having applied wavelength division multiplexing, cost of an optical radio-transmission system cannot be lowered effectively.

[0006] Moreover, by the multi-level modulation method, in order to raise frequency use effectiveness, a light emitting device with little nonlinear distortion of frequency characteristics is needed. However, generally LED which can be received as a general-purpose article cheaply [have the radiant flux strength property of extent which can be used for the optical wireless between the about dozens of m / several m - / away points, for example, and] that is, has the large nonlinear distortion of frequency characteristics. For this reason, a highly efficient thing is required of the equipment for a recovery error correction. Generally such equipment is expensive. Therefore, even if it uses LED for an emitter part, in having applied the multi-level modulation method, cost of an optical radio-transmission system cannot be lowered effectively.

[0007] This invention is made in view of the above-mentioned situation, and the purpose of this invention is in an optical radio-transmission system to realize cheaply the high-speed radio transmission more than the imitation rate which the light emitting device which an emitter part adopts has.

[0008]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, commo data is divided into two or more commo data (it is called division data) at the lightwave signal sending set which changes and carries out light transmission of the commo data to a lightwave signal, each is changed into a lightwave signal, and the processing which carries out juxtaposition light transmission of these from two or more emitter parts which estranged mutually and have been arranged is made to perform in this invention. Moreover, each of the lightwave signal by which juxtaposition light transmission was carried out to the lightwave signal receiving set which receives a lightwave signal and is changed into commo data from said lightwave signal sending set using optical system, and said two or more emitter parts and two or more light sensing portions which counter by 1 to 1 is received, it changes into division data, multiplex [of these] is carried out, and the processing which restores said commo data is made to perform. Here, the spot of the light transmission signal of said emitter part which counters formed of said optical system arranges said two or more light sensing portions so that it may be located on a light-receiving side.

[0009] Two or more emitter parts which carry out light transmission of the lightwave signal according to the division data which possessed a luminescence means to send out the light which is not coherent as for LED etc. in said lightwave signal sending set, drove said luminescence means to it, and were specifically inputted into it, and the serial-parallel transducer which divides commo data into the division data for the number of said emitter part, and carries out a parallel transmission to said two or more emitter parts are prepared. Moreover, multiplex [of the division data by which the juxtaposition output was carried out from said two or more light sensing portions and two or more light sensing portions which counter by 1 to 1 which possess a light-receiving means in said lightwave-signal receiving set, and output the division data according to the lightwave signal which received light with said light-receiving means and two or more of said light sensing portions] carried out, and the juxtaposition-serial transducer which restores said commo data, and the optical department which condense each of the lightwave signal by which juxtaposition light transmission was carried out from said lightwave-signal sending set have prepared. And about each of two or more of said light sensing portions, the spot of the light transmission signal of said emitter part which counters constitutes said optical department so that it may be formed on the light-receiving side of said light-receiving means which said light sensing portion

possesses.

[0010] If an optical radio-transmission system is constituted as mentioned above, even if it uses neither wavelength division multiplexing nor a multi-level modulation method, the high-speed optical radio transmission more than the imitation rate which the light emitting device which an emitter part adopts has is realizable. Thereby, compared with laser equipment, it is cheap, and control uses an easy light emitting device for an emitter part, and can realize a high-speed optical radio-transmission system.

[0011] In addition, in this invention, since the luminescence means with which said two or more emitter parts are equipped sends out the light which is not coherent even if it constitutes said optical department from one optical system (for example, only convex lens), effect by interference of a lightwave signal by which light transmission was carried out from said two or more emitter parts can be made small. Therefore, a still cheaper optical radio-transmission system is realizable.

[0012] Moreover, in this invention, said light-receiving means may possess the control means which turns on and off two or more photo detectors arranged on the light-receiving side, and said two or more photo detectors of each. And it is good to detect the ratio to a different frequency component from said lightwave signal included in said light-receiving signal, and said lightwave signal included in said light-receiving signal of the same frequency component to said control means, and for said ratio to make it turn off said photo detector of under a predetermined value about said two or more photo detectors of each. If it does in this way, justification of the light sensing portion concerned at the time of changing the spot location which said optical department of the light transmission signal from a light sensing portion and the emitter part which counters forms by modification of a transmission distance, for example can be simplified.

[0013]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained.

[0014] Drawing 1 is the schematic diagram of the optical radio-transmission system by which 1 operation gestalt of this invention was applied.

[0015] The optical radio-transmission system of this operation gestalt consists of one pair of optical radio-transmission equipments 1 so that it may illustrate. One pair of these optical radio-transmission equipments 1 carry out the radio transmission of the commo data by sending and receiving mutually the lightwave signal acquired in modulating commo data. Thereby, construction of the transmission media for example, between buildings etc. realizes transmission of commo data between difficult points.

[0016] The transmission-line IF (interface) section 11 in which optical radio-transmission equipment 1 sends and receives commo data through a transmission medium, The lightwave signal transmitting section 12 which changes into a lightwave signal the commo data sent from the transmission medium through the transmission-line IF section 11, and carries out light transmission of this lightwave signal to the optical radio-transmission equipment 1 which counters, The lightwave signal by which light transmission was carried out from the optical radio-transmission equipment 1 which counters is changed into commo data, and it has the lightwave signal receive section 13 which transmits this commo data to a transmission medium through the transmission-line IF section 11.

[0017] The lightwave signal transmitting section 12 has the serial-parallel transducer 121 and two or more emitter parts 122a-122d.

[0018] The serial-parallel transducer 121 changes the output destination change (emitter parts 122a-122d) of the commo data which defined beforehand and was received from the transmission-line IF section 11 according to **** sequence for every predetermined time. And if it changes to said the sequence top last emitter parts

122a-122d, let the next output destination changes be said the sequence top first emitter parts 122a-122d. Thereby, commo data is divided into the emitter parts [122a-122d] commo data for the number (it is called division data), and a parallel transmission is carried out to emitter parts 122a-122d.

[0019] Emitter parts 122a-122d carry out light transmission of the lightwave signal according to the division data received from the serial-parallel transducer 121. Drawing 2 is an emitter parts [122a-122d] schematic diagram. Emitter parts 122a-122d have the modulation section 1221 and LED1222, respectively so that it may illustrate. The modulation section 1221 drives LED1222 and carries out electric - light conversion of the division data received from the serial-parallel transducer 121. Here, emitter parts [122a-122d] LED1222 is held by the LED attaching part 123. The LED attaching part 123 holds each LED1222 on the same flat surface, and the inclination of the optical axis of this flat surface and each LED1222 is constituted possible [adjustment].

[0020] The lightwave signal receive section 13 has the optical department 133, two or more light sensing portions 132a-132d, and the juxtaposition-serial transducer 131.

[0021] The optical department 133 is for condensing each of the lightwave signal by which juxtaposition light transmission was carried out from the emitter parts 122a-122d of the optical radio-transmission equipment 1 which counters, and consists of one optical system (for example, only convex lens).

[0022] Light sensing portions 132a-132d receive a lightwave signal through the optical department 133, and output the division data according to this lightwave signal. Drawing 3 is a light sensing portions [132a-132d] schematic diagram. Light sensing portions 132a-132d have two or more photo detectors (for example, photodiode) 1321, two or more selection sections 1322 prepared every photo detector 1321, an adder unit 1323, and the recovery section 1324, respectively so that it may illustrate. The selection section 1322 turns on and off connection between the corresponding photo detector 1321 and an adder unit 1323. An adder unit 1323 adds the signal sent through two or more selection sections 1322. The recovery section 1324 restores to the addition signal outputted from the adder unit 1323 to division data. Here, the light sensing portions [132a-132d] photo detector 1321 is held by the photo detector attaching part 134. The photo detector attaching part 134 is constituted so that each photo detector 1321 may be held on the same flat surface, and so that the relative physical relationship of this flat surface and the optical department 133 may be kept constant. Moreover, the photo detector attaching part 134 is equipped with the regulatory mechanism for rotating this flat surface by setting a revolving shaft as the optical axis of the optical department 133.

[0023] Drawing 4 is the schematic diagram of the selection section 1322.

[0024] In drawing 4 , in BPF(band pass filter) 13223, the frequency component of the lightwave signal by which light transmission is carried out is extracted, and the output from the front end amplifier 13211 of a photo detector 1321 is sent out through SW13229 to an adder unit 1323 from LED1222 of the optical transmission radio equipment 1 which counters, after a dc component is cut by the capacitor 13222 for a direct-current cut.

[0025] Here, the dc-component detector 13221 detects the dc component of the output signal of the front end amplifier 13211. And if this detection value becomes beyond a predetermined value, the front end amplifier 13211 will judge with what would be in the saturation state, and will start the output of an off signal to the SW control section 13228. The output of this off signal is continued until said detection value becomes said under predetermined value.

[0026] Moreover, a comparator 13227 compares frequency components other than the frequency component of a lightwave signal which were extracted by level, and HPF (high-pass filter)13225 or the low pass filter of the lightwave signal which was extracted by BPF13223 and detected with the envelope wave detector 13224, and

were detected with the envelope wave detector 13226, i.e., the level of white noise. And if it is under a predetermined value, the ratio, i.e., the S/N value, over the White noise level of lightwave signal level, the photo detector 1321 will not have received the lightwave signal, or will judge with being influenced by outdoor daylight, such as sunlight, and will start the output of an off signal to the SW control section 13228. The output of this off signal is continued until said ratio becomes said beyond predetermined value.

[0027] From the dc-component detector 13221 or a comparator 13227, the SW control section 13228 controls SW13229 during the period when the off signal is outputted, and turns OFF connection between a photo detector 1321 and an adder unit 1323.

[0028] Here, drawing 5 is used and relative physical relationship with the photo detector 1321 which counters LED1222 between one pair of optical radio-transmission equipments 1 and this LED1222 is explained.

[0029] As shown in drawing 5 , suppose that it has arranged it in it as the optical axis b of the light-transmission signal of LED1222 passed along the principal point o of the optical department 133 in the location where only distance D separated LED1222 of optical radio-transmission equipment 1 from the optical axis a and the intersection q of a flat surface A on the perpendicular flat surface A to the optical axis a of the optical department (here convex lens chisel) 133 of the optical radio-transmission equipment 1 which counters this optical radio-transmission equipment 1. It is the location where only distance S separated the distance (transmission distance) from a flat surface A to the principal point o from the optical axis a and the intersection p of a flat surface B on the flat surface B which the light-receiving spot of LED1222 is a perpendicular flat surface to the optical axis a of the optical department 133, and only the focal distance f separated from the optical department 133 when the focal distance of L and an optical department was set to f, and it is formed in the location of the opposite side in LED1222 to an optical axis a. Here, there is the following relation to distance S and distance D.

[0030]

distance S= (distance Dx focal distance f) / transmission distance L -- there -- this operation gestalt -- the LED attaching part 123 -- an emitter part 122 -- as shown in drawing 6 , a-122d of each LED1222 is arranged so that it may become point symmetry to Intersection q. And it enables it to adjust the optical axis b of the light transmission signal of each LED1222.

[0031] moreover, the photo detector attaching part 134 -- a light sensing portion 132 -- a-132d of two or more photo detectors 1321 of each is arranged to the single tier at intervals of predetermined (however, it is made for the distance s between photo detectors to become smaller than the diameter of a light-receiving spot), as shown in drawing 7 . the emitter part 122 which counters by this about light sensing portion 132a-132d of each -- if the light-receiving spot of each LED1222 is the transmission distance L of predetermined within the limits, he is trying to locate it on one of the photo detectors 1321 a-122d

[0032] for example, the focal distance f of the optical department 133 -- the diameter of 200mm and a light-receiving spot -- the diameter of 0.2mm and a photo detector -- 0.1mm -- and When distance D from Intersection q to each LED1222 is set to 100mm, two or more photo detectors 1321 about light sensing portion 132a-132d of each with a distance [from Intersection p] of S= 0.2mm - 2mm in between If it is transmission-distance L=10m-100m by arranging at intervals of 0.2mm, a light-receiving spot can be formed on one of the photo detectors 1321. In addition, as mentioned above, a light-receiving spot location gap of the hand of cut centering on Intersection p is adjusted by the photo detector attaching part 134.

[0033] It returns to drawing 1 and explanation is continued.

[0034] the division data with which the juxtaposition output of the juxtaposition-serial transducer 131 was

carried out from two or more light sensing portions 132a-132d -- said -- beforehand -- a law -- according to **** sequence (change sequence of the communication link data output point in the serial-parallel transducer 121), said predetermined time (change spacing of the communication link data output point in the serial-parallel transducer 121) is multiplexed as a unit. This restores commo data and the restored commo data is sent out to a transmission medium through the transmission-line IF section 11.

[0035] Next, actuation of the optical radio-transmission system shown in drawing 1 is explained.

[0036] In the optical radio-transmission equipment 1 by the side of light transmission, from a transmission medium, the transmission-line IF section 11 receives commo data, and outputs this to the serial-parallel transducer 121 of the lightwave signal transmitting section 12. The serial-parallel transducer 121 is changing the output destination change (emitter parts 122a-122d) of the commo data which defined beforehand and was received from the transmission-line IF section 11 according to **** sequence for every predetermined time, and it divides commo data into the emitter parts [122a-122d] division data for the number, and it carries out a parallel transmission to emitter parts 122a-122d. Emitter parts [122a-122d] each carries out light transmission of the lightwave signal according to the division data received from the serial-parallel transducer 121 to the optical radio-transmission equipment 1 by the side of light-receiving.

[0037] here, each emitter parts [122a-122d] LED1222 was shown in drawing 5 and drawing 6 -- as -- the LED attaching part 123 -- the same flat-surface A top -- and it is held so that this flat surface A may become perpendicular to the optical axis a of the optical department 133 with which the optical radio-transmission equipment 1 of a receiving side is equipped. Furthermore, each LED1222 is adjusted so that the optical axis b of a light transmission signal may pass the principal point o of the optical department 133 with which the optical radio-transmission equipment 1 of a receiving side is equipped by the LED attaching part 123.

[0038] On the other hand, in the optical radio-transmission equipment 1 by the side of light-receiving, light sensing portions [132a-132d] ******** receives light by two or more photo detectors 1321 which self equips with an emitter parts [which counter / 122a-122d (emitter parts 122a-122d with which the optical radio-transmission equipment 1 by the side of light transmission is equipped)] lightwave signal through the optical department 133, and it restores to it to division data. And the division data to which it restored are sent out to the juxtaposition-serial transducer 131.

[0039] Here, as shown in drawing 5 and drawing 7 , to the optical axis a of the optical department 133, two or more photo detectors 1321 with which light sensing portion 132a-132d of each is equipped are perpendicular, and are held by the photo detector attaching part 134 on the same flat surface B in which the light-receiving spot by the optical department 133 is formed. And since it enables it to correspond to modification of a transmission distance L, it arranges on this flat surface B at the single tier. Each light sensing portions 132a-132d receive the lightwave signal from self and the emitter parts 122a-122d which counter by the photo detector 1321 in the light-receiving spot location of this lightwave signal. As for the photo detector 1321 which is not in a light-receiving spot location, connection with an adder unit 1323 is turned OFF.

[0040] Now, from light sensing portions 132a-132d, the juxtaposition-serial transducer 131 multiplexes the division data by which the juxtaposition output was carried out, restores commo data, and sends out the restored commo data to a transmission medium through the transmission-line IF section 11.

[0041] Transmission of commo data between the points where construction of the transmission media for example, between buildings etc. is difficult is realized by the above actuation.

[0042] In the above, 1 operation gestalt of this invention was explained.

[0043] Commo data is divided into two or more division data at the lightwave signal transmitting section 12,

each is changed into a lightwave signal, and the processing which carries out juxtaposition light transmission from two or more emitter parts 122a-122d which estranged these mutually and have been arranged is made to perform with this operation gestalt, as mentioned above. Moreover, each of the lightwave signal by which juxtaposition light transmission was carried out to the lightwave signal receive section 13 from the optical radio-transmission equipment 1 of a communications partner using the optical department 133, and two or more emitter parts 122a-122d with which the optical radio-transmission equipment 1 of a communications partner is equipped and two or more light sensing portions 132a-132d which counter by 1 to 1 is received, it changes into division data, multiplex [of these] is carried out, and the processing which restores commo data is made to perform. Here, two or more light sensing portions 132a-132d are arranged so that the spot of the emitter parts [which counter / 122a-122d] light transmission signal formed of the optical department 133 may be located on a light-receiving side.

[0044] Therefore, according to this operation gestalt, even if it uses neither wavelength division multiplexing nor a multi-level modulation method, the high-speed optical radio transmission more than the imitation rate which LED1222 which emitter parts 122a-122d adopt has is realizable. For example, when a signal band realizable at the imitation rate which LED1222 has is set to 25Mbps(es), it becomes possible like this operation gestalt to carry out the radio transmission of the commo data of 100Mbps by preparing one pair of emitter parts, and four receive sections, respectively. Thereby, compared with laser equipment, it is cheap, and LED with easy control is used for an emitter part, and a high-speed optical radio-transmission system can be realized.

[0045] Moreover, with this operation gestalt, it is condensing so that each of the lightwave signal by which juxtaposition light transmission was carried out to the light-receiving side from the emitter parts 122a-122d by the side of light transmission can be received by the light sensing portions 122a-122d which counter using the optical department 133 which consists of one optical system (for example, only convex lens). For this reason, a still cheaper optical radio-transmission system is realizable.

[0046] In addition, LED1222 which sends out the light which is not coherent as a light emitting device is used for emitter parts 122a-122d. moreover, two or more emitter parts 122 which estranged mutually and have been arranged -- each LED1222 is made for a-122d of opticals axis b of a light transmission signal not to become parallel mutually so that the optical axis b of a light transmission signal may pass the principal point o of the optical department 133 by the side of light-receiving that is, Therefore, even if it condenses each of the lightwave signal by which juxtaposition light transmission was carried out from the emitter parts 122a-122d of a transmitting side in the optical department 133 which becomes by one optical system, effect by interference of a lightwave signal etc. can be made small.

[0047] Moreover, in this operation gestalt, light sensing portions [132a-132d] each possesses two or more photo detectors 1321 arranged on the same side, and two or more selection sections 1322 prepared every photo detector 1321.

[0048] And the frequency component same about the photo detector 1321 corresponding to the selection section 1322 as the lightwave signal included in a light-receiving signal, Make the ratio to a different frequency component from said lightwave signal included in said light-receiving signal detect, and if this ratio is under a predetermined value, [whether the photo detector 1321 has received the lightwave signal and] Or connection with the adder unit 1323 of the corresponding photo detector 1321 is made to turn off until it judges with being influenced by outdoor daylight, such as sunlight, and this ratio becomes said beyond predetermined value.

[0049] Moreover, connection with the adder unit 1323 of the corresponding photo detector 1321 is made to turn off until it will judge with that from which the front end amplifier 13211 would be in the saturation state and

this dc component will become said under predetermined value, if the dc component of the signal from the corresponding front end amplifier 13211 of a photo detector 1321 is made to detect and this dc component becomes beyond a predetermined value.

[0050] Since only the photo detector 1321 in which the light-receiving spot of a lightwave signal is formed among two or more photo detectors 1321 is connectable with an adder unit 1323 by doing in this way, for example, even when the spot location of the light transmission signal which are emitter parts 122a-122d which a transmission distance L is changed, consequently the optical department 133 forms changes, light can be received by the light sensing portions 132a-132d which counter these emitter parts 122a-122d. Therefore, justification of emitter parts 122a-122d or light sensing portions 132a-132d can be simplified. Moreover, effect by outdoor daylight, such as sunlight, can be made small by doing in this way.

[0051] In addition, this invention is not limited to the above-mentioned operation gestalt, and many deformation of it becomes possible within the limits of the summary.

[0052] For example, what is necessary is not to be limited to this but just to prepare two or more each of an emitter part and a light sensing portion with the above-mentioned operation gestalt, although emitter parts 122a-122d and four light sensing portions 132a-132d are formed, respectively.

[0053] Moreover, if the light emitting device used for emitter parts 122a-122d has the radiant flux strength property of extent which can be used for optical wireless and light transmission of the light which is not coherent is carried out, it will not be limited to LED.

[0054] Moreover, two or more photo detectors 1321 with which emitter part 122a-122d of each is equipped are not restricted to what has been arranged in one train, as shown in drawing 7 . If two or more photo detectors 1321 with which emitter part 122a-122d of each is equipped are arranged in two or more trains as shown in drawing 8 , it will become unnecessary for example, to adjust a light-receiving spot location gap of the hand of cut centering on Intersection p by the photo detector attaching part 134. For this reason, justification of emitter parts 122a-122d or light sensing portions 132a-132d can be simplified further.

[0055] In addition, one photo detector 1321 is formed in light sensing portions [132a-132d] each, and you may enable it to justify each photo detector 1321.

[0056] Moreover, in this operation gestalt, when not performing two-way communication, the lightwave signal receive section 13 may be omitted from the optical radio-transmission equipment 1 by the side of light transmission, and the lightwave signal transmitting section 12 may be omitted from the optical radio-transmission equipment 1 by the side of light-receiving.

[0057]

[Effect of the Invention] As explained above, according to this invention, the high-speed optical radio transmission more than the imitation rate which the light emitting device which an emitter part adopts has is realizable.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the schematic diagram of the optical radio-transmission system by which 1 operation gestalt of this invention was applied.

[Drawing 2] It is an emitter parts [which are shown in drawing 1 / 122a-122d] schematic diagram.

[Drawing 3] It is a light sensing portions [which are shown in drawing 1 / 132a-132d] schematic diagram.

[Drawing 4] It is the schematic diagram of the selection section 1322 shown in drawing 3 .

[Drawing 5] In one pair of optical radio-transmission equipments 1 shown in drawing 1 , it is drawing for explaining the relative physical relationship of LED1222 and the photo detector 1321 which counters this LED1222.

[Drawing 6] the emitter part 122 shown in drawing 2 -- it is drawing showing a-122d of examples of arrangement of each LED1222.

[Drawing 7] the light sensing portion 132 shown in drawing 3 -- it is drawing showing a-132d of examples of arrangement of two or more photo detectors 1321 of each.

[Drawing 8] the light sensing portion 132 shown in drawing 3 -- it is drawing showing a-132d (modification) of examples of arrangement of two or more photo detectors 1321 of each.

[Description of Notations]

1 -- Optical radio-transmission equipment

11 -- The transmission-line IF section

12 -- Lightwave signal transmitting section

13 -- Lightwave signal receive section

121 -- Serial-parallel transducer

122a-122d -- Emitter part

123 -- LED attaching part

131 -- Juxtaposition-serial transducer

132a-132d -- Light sensing portion

133 -- Optical department

134 -- Photo detector attaching part

1221 -- Modulation section

1222 -- LED

1321 -- Photo detector

1322 -- Selection section

1323 -- Adder unit

1324 -- Recovery section

13211 -- Front end amplifier

13221 -- Dc-component detector

13222 -- Capacitor for a direct-current cut

13223 -- BPF

13224 13226 -- Envelope wave detector

13225 -- HPF

13227 -- Comparator
13228 -- SW control section
13229 -- SW

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the schematic diagram of the optical radio-transmission system by which 1 operation gestalt of this invention was applied.
[Drawing 2] It is an emitter parts [which are shown in drawing 1 / 122a-122d] schematic diagram.
[Drawing 3] It is a light sensing portions [which are shown in drawing 1 / 132a-132d] schematic diagram.
[Drawing 4] It is the schematic diagram of the selection section 1322 shown in drawing 3 .
[Drawing 5] In one pair of optical radio-transmission equipments 1 shown in drawing 1 , it is drawing for explaining the relative physical relationship of LED1222 and the photo detector 1321 which counters this LED1222.
[Drawing 6] the emitter part 122 shown in drawing 2 -- it is drawing showing a-122d of examples of arrangement of each LED1222.
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[Description of Notations]
1 -- Optical radio-transmission equipment
11 -- The transmission-line IF section
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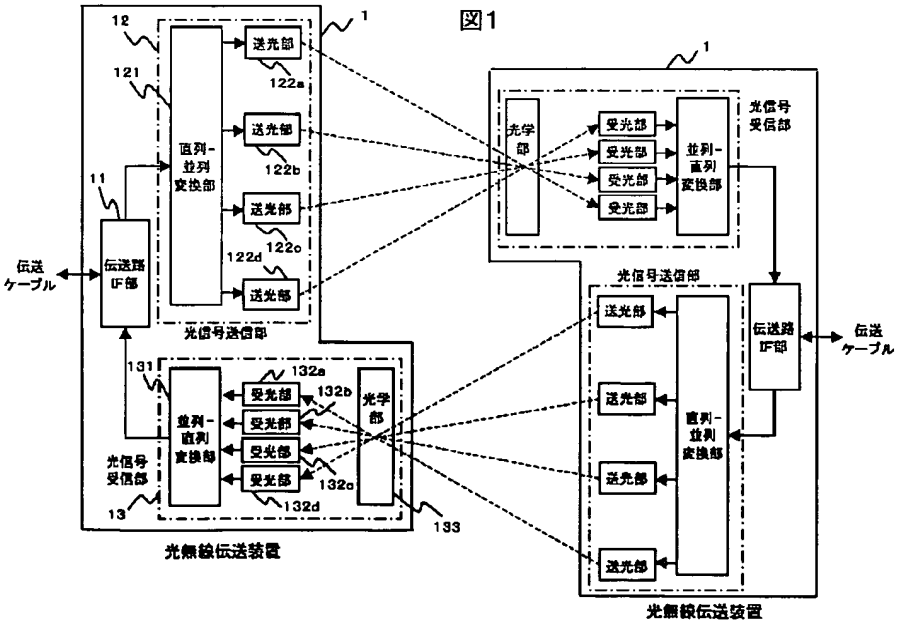
134 -- Photo detector attaching part
1221 -- Modulation section

1222 -- LED
1321 -- Photo detector
1322 -- Selection section
1323 -- Adder unit
1324 -- Recovery section
13211 -- Front end amplifier
13221 -- Dc-component detector
13222 -- Capacitor for a direct-current cut
13223 -- BPF
13224 13226 -- Envelope wave detector
13225 -- HPF
13227 -- Comparator
13228 -- SW control section
13229 -- SW

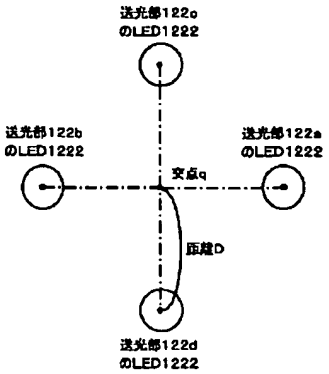
DRAWINGS

[Drawing 1]



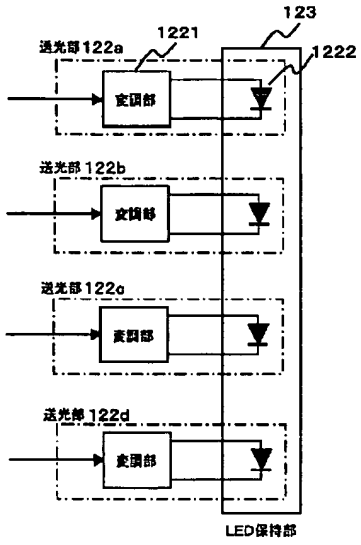
[Drawing 6]

図6



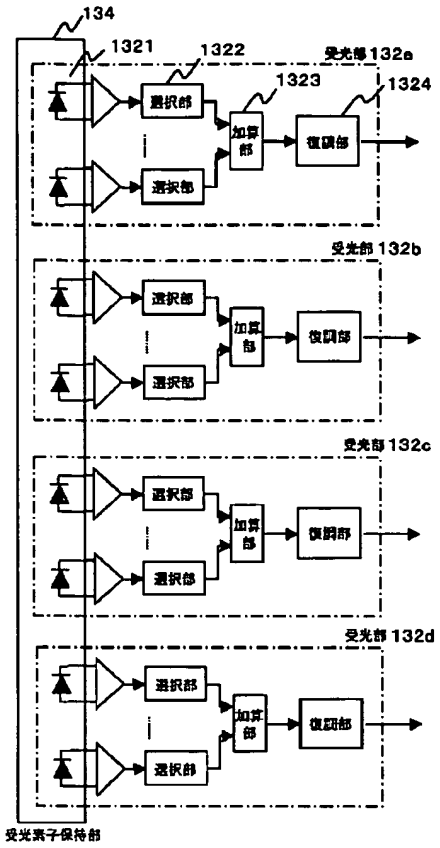
[Drawing 2]

図2



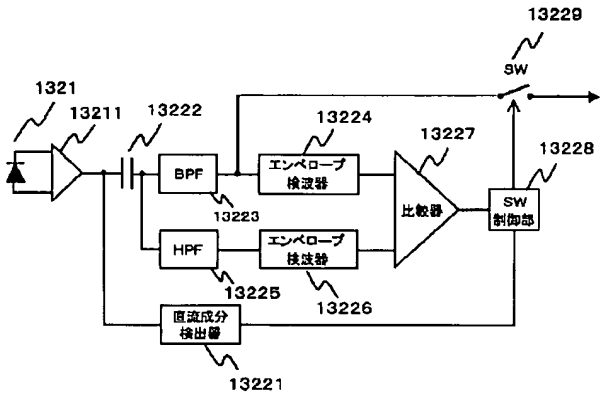
[Drawing 3]

図3



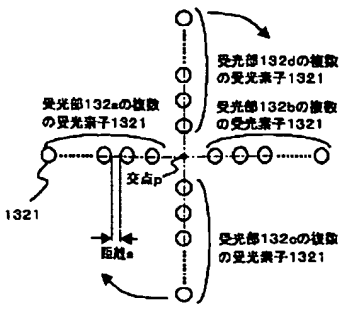
[Drawing 4]

図4



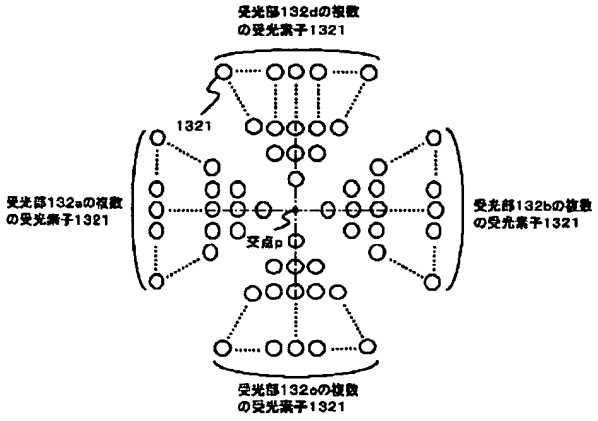
[Drawing 7]

図7



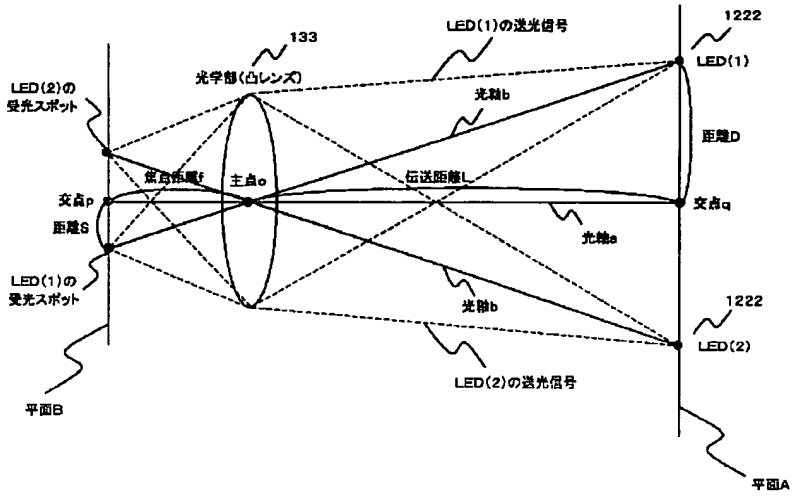
[Drawing 8]

図8



[Drawing 5]

図5



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10/00			Ｂ	
10/105				
10/22				

審査請求　未請求　請求項の数８　ＯＬ　（全９頁）

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Ｆターム(参考)　5K002 AA01 AA03 BA02 BA14 CA02
DA04 DA05 FA03

(54)【発明の名称】　光無線伝送システムおよび光無線伝送方法

(57)【要約】
【課題】発光素子が持つ追随速度以上の高速な光無線伝送を実現する。
【解決手段】光信号送信部１２に、通信データを複数の分割データに分割してそれぞれをコヒーレントでない光信号に変換し、これらを複数の送光部１２２ａ～１２２ｄから並列送光させる。また、光信号受信部１３に、光学部１３３および通信相手の光無線伝送装置１が備える複数の送光部１２２ａ～１２２ｄと１対１で対向する複数の受光部１３２ａ～１３２ｄを用いて、通信相手の光無線伝送装置１より並列送光された光信号各々を受光して分割データに変換し、多重して通信データを復元させる。ここで、複数の受光部１３２ａ～１３２ｄは、光学部１３３によって形成される、対向する送光部１２２ａ～１２２ｄの送光信号のスポットが受光面上に位置するように配置されている。

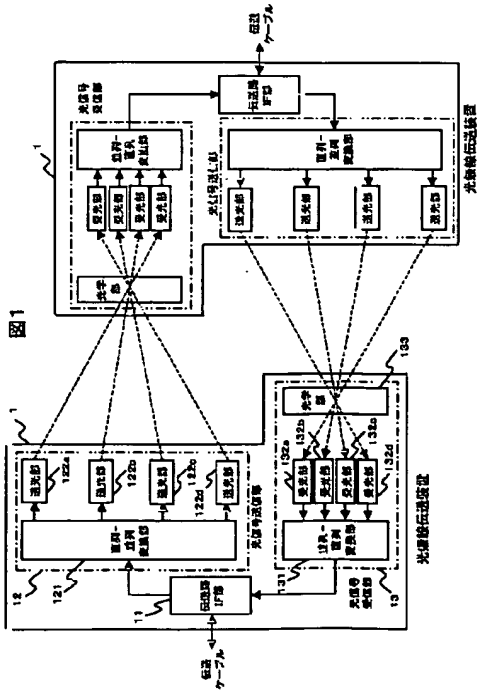


図1

【特許請求の範囲】
【請求項１】通信データを光信号に変換して送光する光信号送信装置と、光信号を受光して通信データに変換する光信号受信装置とを含む光無線伝送システムであって、
前記光信号送信装置は、
コヒーレントでない光を送出する発光手段を具備し、前記発光手段を駆動して、入力されたデータに応じた光信号を送光する複数の送光部と、
通信データを前記送光部の個数分の通信データ（分割データと呼ぶ）に分割して、前記複数の送光部へ並列伝送する直列-並列変換部と、を有し、
前記光信号受信装置は、
受光手段を具備し、前記受光手段で受光した光信号に応じた分割データを出力する、前記複数の送光部と１対１で対向する複数の受光部と、
前記複数の受光部から並列出力された分割データを多重して、前記通信データを復元する並列-直列変換部と、
前記光信号送信装置より並列送光された光信号のそれぞれを集光する光学部と、を有し、
前記光学部は、
前記複数の受光部のそれぞれについて、対向する前記送光部の送光信号のスポットが、前記受光部が具備する前記受光手段の受光面上に形成されるように、構成されていることを特徴とする光無線伝送システム。
【請求項２】請求項１記載の光無線伝送システムであって、
前記光学部は、一系統の光学系であることを特徴とする光無線伝送システム。
【請求項３】請求項２記載の光無線伝送システムであって、
前記発光手段は、ＬＥＤであり、
前記光学部は、凸レンズで構成されていることを特徴とする光無線伝送システム。
【請求項４】請求項１、２または３記載の光無線伝送システムであって、
前記受光手段は、
受光面上に配列された複数の受光素子と、前記複数の受光素子各々をオン・オフする制御手段と、を具備し、
前記制御手段は、
前記複数の受光素子各々について、前記受光信号に含まれる前記光信号と同じ周波数成分の、前記受光信号に含まれる前記光信号と異なる周波数成分に対する比率を検出し、前記比率が所定値未満の前記受光素子をオフすることを特徴とする光無線伝送システム。
【請求項５】請求項１、２、３または４記載の光信号送信装置。
【請求項６】請求項１、２、３または４記載の光信号受信装置。
【請求項７】１対の光無線伝送装置間で光無線通信を行なう光無線伝送装置であって、
通信データを光信号に変換して対向する前記光無線伝送装置へ送光するための請求項１、２、３または４記載の光信号送信装置と、
対向する前記光無線伝送装置から送光された光信号を受光して通信データに変換するための請求項１、２、３または４記載の光信号受信装置と、を有することを特徴とする光無線伝送装置。
【請求項８】通信データを光信号に変換して送光する光信号送信装置と、光信号を受光して通信データに変換する光信号受信装置とを用いた光無線伝送方法であって、
前記光信号送信装置は、
通信データを複数の通信データ（分割データと呼ぶ）に分割して、それぞれをコヒーレントでない光で形成された光信号に変換し、これらを複数の送光部から並列送光する処理を行ない、
前記光信号受信装置は、
前記複数の送光部と１対１で対向し、光学系によって形成される、対向する前記送光部の送光信号のスポットが、受光面上に位置するように配置された複数の受光部を用いて、前記並列送光された光信号のそれぞれを受光して分割データに変換し、これらを多重して、前記通信データを復元する処理を行なうことを特徴とする光無線伝送方法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、光信号を用いて無線伝送を行なう技術に関する。
【０００２】
【従来の技術】従来より、光信号を用いて無線伝送を行なう光無線伝送システムが、例えばビル間などの伝送ケーブルの敷設が困難な地点間での、通信データの伝送に用いられている。一般に、光無線伝送システムは、それぞれが送光部および受光部を備えた１対の光無線伝送装置で構成される。そして、この１対の光無線伝送装置間で、通信データを変調することで得られる光信号を送受することにより、通信データを無線伝送する。
【０００３】
【発明が解決しようとする課題】上述したような光無線伝送システムにおいて、従来は、送光部に追随速度（オン・オフ切替え速度）の速いレーザ装置を用いることにより、高速な無線伝送を実現していた。しかし、レーザ装置は、「高価である」、「寿命が短い」、「制御系が複雑になる」などの欠点を有しており、送光部にレーザ装置を用いると、光無線伝送システムのコスト（製品コスト、保守・運用コスト）が高くなってしまう。このため、例えばＬＥＤ（Light Emitting Diode）などの、レーザ装置に比べて、追随速度は遅いけれども安価で制御が簡単な発光素子を、送光部に利用して、高速な無線伝送を実現することが望まれる。

【0004】ここで、発光素子が持つ追随速度以上の高速な無線伝送を実現するための技術として、波長分割多重（WDM）方式や、QPSK（Quadrature Phase Shift Keying）、QAM（Quadrature Amplitude Modulation）などの多値変調方式がある。しかし、LEDなどのレーザ装置に比べて安価で制御が簡単な発光素子を送光部に用いた光無線伝送システムに、これらの技術を適用すると、以下のような問題が生ずる。

【0005】すなわち、波長分割多重方式では、互いに異なる波長の光を送光する発光素子が複数必要になる。しかし、例えば、数m～数十m程度離れた地点間の光無線に利用できる程度の放射束強度特性を持ち、送光波長以外の特性が同等であるLEDを、安価につまり汎用品として複数入手することは困難である。云いかえれば、送光波長以外の特性が同等であるLEDを複数用意するためには、LEDの製造メーカなどに特注しなければならい。このようなLEDは、一般に汎用品に比べて高価である。また、波長分割多重された光信号を分離するための光学フィルタが必要となる。このため、受光部側の光学系が複雑・高価となる。したがって、送光部にLEDを利用しても、波長分割多重方式を適用したのでは、光無線伝送システムのコストを効果的に下げることはできない。

【0006】また、多値変調方式では、周波数利用効率を高めるために、周波数特性の非線形歪みが少ない発光素子が必要になる。しかし、例えば、数m～数十m程度離れた地点間の光無線に利用できる程度の放射束強度特性を持ち、安価につまり汎用品として入手することが可能なLEDは、一般に、周波数特性の非線形歪みが大きい。このため、復調誤り訂正のための装置に高性能なものが要求される。このような装置は、一般に高価である。したがって、送光部にLEDを利用しても、多値変調方式を適用したのでは、光無線伝送システムのコストを効果的に下げることはできない。

【0007】本発明は、上記事情に鑑みてなされたものであり、本発明の目的は、光無線伝送システムにおいて、送光部が採用する発光素子が持つ追随速度以上の高速な無線伝送を、安価に実現することにある。

【0008】

【課題を解決するための手段】上記課題を解決するために、本発明では、通信データを光信号に変換して送光する光信号送信装置に、通信データを複数の通信データ（分割データと呼ぶ）に分割してそれぞれを光信号に変換し、これらを互いに離間して配置された複数の送光部から並列送光する処理を行なわせている。また、光信号を受光して通信データに変換する光信号受信装置に、光学系と、前記複数の送光部と１対１で対向する複数の受光部とを用いて、前記光信号送信装置より並列送光された光信号のそれぞれを受光して分割データに変換し、これらを多重して、前記通信データを復元する処理を行なわせている。ここで、前記複数の受光部は、前記光学系によって形成される、対向する前記送光部の送光信号のスポットが、受光面上に位置するように配置する。

【0009】具体的には、前記光信号送信装置に、LEDなどのコヒーレントでない光を送出する発光手段を具備し、前記発光手段を駆動して、入力された分割データに応じた光信号を送光する複数の送光部と、通信データを前記送光部の個数分の分割データに分割して、前記複数の送光部へ並列伝送する直列-並列変換部と、を設けている。また、前記光信号受信装置に、受光手段を具備し、前記受光手段で受光した光信号に応じた分割データを出力する、前記複数の受光部と１対１で対向する複数の受光部と、前記複数の受光部から並列出力された分割データを多重して、前記通信データを復元する並列-直列変換部と、前記光信号送信装置より並列送光された光信号のそれぞれを集光する光学部と、を設けている。そして、前記光学部を、前記複数の受光部のそれぞれについて、対向する前記送光部の送光信号のスポットが、前記受光部が具備する前記受光手段の受光面上に形成されるように構成している。

【0010】以上のように光無線伝送システムを構成すれば、波長分割多重方式や多値変調方式を用いなくても、送光部が採用する発光素子が持つ追随速度以上の高速な光無線伝送を実現できる。これにより、レーザ装置に比べて安価で制御が簡単な発光素子を送光部に用いて、高速な光無線伝送システムを実現できる。

【0011】なお、本発明において、前記光学部を一系統の光学系（例えば凸レンズのみ）で構成しても、前記複数の送光部が備える発光手段はコヒーレントでない光を送出するので、前記複数の送光部から送光された光信号の干渉等による影響を小さくできる。したがって、さらに安価な光無線伝送システムを実現できる。

【0012】また、本発明において、前記受光手段は、受光面上に配列された複数の受光素子と、前記複数の受光素子各々をオン・オフする制御手段とを具備するものでもよい。そして、前記制御手段に、前記複数の受光素子各々について、前記受光信号に含まれる前記光信号と同じ周波数成分の、前記受光信号に含まれる前記光信号と異なる周波数成分に対する比率を検出し、前記比率が所定値未満の前記受光素子をオフさせるとよい。このようにすれば、例えば、伝送距離の変更により、受光部と対向する送光部からの送光信号の、前記光学部が形成するスポット位置が変化した場合における、当該受光部の位置調整を簡素化できる。

【0013】

【発明の実施の形態】以下、本発明の実施の形態について説明する。

【0014】図１は本発明の一実施形態が適用された光無線伝送システムの概略図である。

【0015】図示するように、本実施形態の光無線伝送

システムは、1対の光無線伝送装置1で構成される。この1対の光無線伝送装置1は、通信データを変調することで得られる光信号を互いに送受することにより、通信データを無線伝送する。これにより、例えばビル間などの伝送ケーブルの敷設が困難な地点間での、通信データの伝送を実現する。

【0016】光無線伝送装置1は、伝送ケーブルを介して通信データを送受する伝送路IF（インターフェース）部11と、伝送路IF部11を介して伝送ケーブルから送られてきた通信データを光信号に変換し、対向する光無線伝送装置1へこの光信号を送光する光信号送信部12と、対向する光無線伝送装置1より送光された光信号を通信データに変換し、伝送路IF部11を介して伝送ケーブルへこの通信データを送信する光信号受信部13と、を有する。

【0017】光信号送信部12は、直列-並列変換部121と、複数の送光部122a～122dと、を有する。

【0018】直列-並列変換部121は、所定時間毎に、予め定められた順番に従い、伝送路IF部11より受け取った通信データの出力先（送光部122a～122d）を切り替える。そして、前記順番上最後の送光部122a～122dに切り替えたならば、次の出力先を、前記順番上最初の送光部122a～122dとする。これにより、通信データを送光部122a～122dの個数分の通信データ（分割データと呼ぶ）に分割して、送光部122a～122dへ並列伝送する。

【0019】送光部122a～122dは、直列-並列変換部121より受け取った分割データに応じた光信号を送光する。図2は、送光部122a～122dの概略図である。図示するように、送光部122a～122dは、それぞれ、変調部1221とLED1222とを有する。変調部1221は、LED1222を駆動して、直列-並列変換部121より受け取った分割データを電気-光変換する。ここで、送光部122a～122dのLED1222は、LED保持部123によって保持されている。LED保持部123は、各LED1222を同一平面上に保持しており、且つ、この平面および個々のLED1222の光軸の傾きを、調整可能に構成されている。

【0020】光信号受信部13は、光学部133と、複数の受光部132a～132dと、並列-直列変換部131と、を有する。

【0021】光学部133は、対向する光無線伝送装置1の送光部122a～122dから並列送光された光信号のそれぞれを集光するためのものであり、1系統の光学系（例えば凸レンズのみ）で構成される。

【0022】受光部132a～132dは、光学部133を介して光信号を受光し、この光信号に応じた分割データを出力する。図3は、受光部132a～132dの概略図である。図示するように、受光部132a～132dは、それぞれ、複数の受光素子（例えばフォトダイオード）1321と、受光素子1321毎に設けられた複数の選択部1322と、加算部1323と、復調部1324と、を有する。選択部1322は、対応する受光素子1321および加算部1323間の接続をオン・オフする。加算部1323は、複数の選択部1322を介して送られてきた信号を加算する。復調部1324は、加算部1323より出力された加算信号を分割データに復調する。ここで、受光部132a～132dの受光素子1321は、受光素子保持部134によって保持されている。受光素子保持部134は、各受光素子1321を同一平面上に保持するように、且つ、この平面と光学部133との相対的な位置関係が一定に保たれるように構成されている。また、受光素子保持部134は、光学部133の光軸を回転軸として、この平面を回動するための調節機構を備えている。

【0023】図4は、選択部1322の概略図である。

【0024】図4において、受光素子1321のフロントエンドアンプ13211からの出力は、直流カット用コンデンサ13222にて直流成分がカットされた後、BPF（バンドパスフィルタ）13223にて、対向する光伝送無線装置1のLED1222より送光される光信号の周波数成分が抽出され、SW13229を介して加算部1323へ送出される。

【0025】ここで、直流成分検出器13221は、フロントエンドアンプ13211の出力信号の直流成分を検出する。そして、この検出値が所定値以上ならば、フロントエンドアンプ13211が飽和状態になったものと判定し、SW制御部13228にオフ信号の出力を開始する。このオフ信号の出力を、前記検出値が前記所定値未満となるまで続ける。

【0026】また、比較器13227は、BPF13223で抽出され、エンベロープ検波器13224で検波された光信号のレベルと、HPF（ハイパスフィルタ）13225もしくはローパスフィルタにて抽出され、エンベロープ検波器13226で検波された、光信号の周波数成分以外の周波数成分、つまり、ホワイトノイズのレベルとを比較する。そして、光信号レベルのホワイトノイズレベルに対する比率つまりS/N値が所定値未満ならば、受光素子1321が光信号を受信していないか、あるいは、太陽光等の外光による影響を受けていると判定し、SW制御部13228にオフ信号の出力を開始する。このオフ信号の出力を、前記比率が前記所定値以上となるまで続ける。

【0027】SW制御部13228は、直流成分検出器13221もしくは比較器13227よりオフ信号が出力されている期間中、SW13229を制御して、受光素子1321および加算部1323間の接続をオフにする。

【００２８】ここで、図５を用いて、１対の光無線伝送装置１間における、ＬＥＤ１２２２とこのＬＥＤ１２２２に対向する受光素子１３２１との相対的な位置関係について説明する。

【００２９】図５に示すように、光無線伝送装置１のＬＥＤ１２２２を、この光無線伝送装置１に対向する光無線伝送装置１の光学部（ここでは凸レンズのみ）１３３の光軸ａに対し垂直な平面Ａ上の、光軸ａおよび平面Ａの交点ｑから距離Ｄだけ離れた位置に、ＬＥＤ１２２２の送光信号の光軸ｂが光学部１３３の主点ｏを通るようにして配置したとする。平面Ａから主点ｏまでの距離（伝送距離）をＬ、光学部の焦点距離をｆとした場合、ＬＥＤ１２２２の受光スポットは、光学部１３３の光軸ａに対し垂直な平面であって光学部１３３から焦点距離ｆだけ離れた平面Ｂ上の、光軸ａおよび平面Ｂの交点ｐから距離Ｓだけ離れた位置であって、光軸ａに対しＬＥＤ１２２２とは反対側の位置に形成される。ここで、距離Ｓと距離Ｄには、以下の関係がある。

【００３０】

距離Ｓ＝（距離Ｄ×焦点距離ｆ）/伝送距離Ｌ

そこで、本実施形態では、ＬＥＤ保持部１２３により、送光部１２２ａ～１２２ｄ各々のＬＥＤ１２２２を、図６に示すように、交点ｑに対し点対称となるように配置している。そして、各ＬＥＤ１２２２の送光信号の光軸ｂを調節できるようにしている。

【００３１】また、受光素子保持部１３４により、受光部１３２ａ～１３２ｄ各々の複数の受光素子１３２１を、図７に示すように、所定間隔（但し、受光素子間距離ｓが受光スポットの直径よりも小さくなるようにする）で一列に配置している。これにより、受光部１３２ａ～１３２ｄ各々について、対向する送光部１２２ａ～１２２ｄ各々のＬＥＤ１２２２の受光スポットが、所定範囲内の伝送距離Ｌであれば、いずれかの受光素子１３２１上に位置するようにしている。

【００３２】例えば、光学部１３３の焦点距離ｆを２００ｍｍ、受光スポットの直径を０．２ｍｍ、受光素子の直径を０．１ｍｍ、そして、交点ｑから各ＬＥＤ１２２２までの距離Ｄを１００ｍｍとした場合、受光部１３２ａ～１３２ｄ各々について、複数の受光素子１３２１を、交点ｐからの距離Ｓ＝０．２ｍｍ～２ｍｍの間に、０．２ｍｍ間隔で配列することにより、伝送距離Ｌ＝１０ｍ～１００ｍであれば、いずれかの受光素子１３２１上に受光スポットが形成されるようにすることができる。なお、上述したように、交点ｐを中心とした回転方向の受光スポット位置ずれは、受光素子保持部１３４により調節する。

【００３３】図１に戻って説明を続ける。

【００３４】並列-直列変換部１３１は、複数の受光部１３２ａ～１３２ｄより並列出力された分割データを、前記予め定められた順番（直列-並列変換部１２１での通信データ出力先の切替順番）に従い、前記所定時間（直列-並列変換部１２１での通信データ出力先の切替間隔）を単位として多重化する。これにより通信データを復元し、復元した通信データを、伝送路ＩＦ部１１を介して伝送ケーブルへ送出する。

【００３５】次に、図１に示す光無線伝送システムの動作について説明する。

【００３６】送光側の光無線伝送装置１において、伝送路ＩＦ部１１は、伝送ケーブルより通信データを受信して、これを光信号送信部１２の直列-並列変換部１２１へ出力する。直列-並列変換部１２１は、所定時間毎に、予め定めれた順番に従い、伝送路ＩＦ部１１より受け取った通信データの出力先（送光部１２２ａ～１２２ｄ）を切り替えることで、通信データを送光部１２２ａ～１２２ｄの個数分の分割データに分割して、送光部１２２ａ～１２２ｄへ並列伝送する。送光部１２２ａ～１２２ｄのそれぞれは、直列-並列変換部１２１より受け取った分割データに応じた光信号を受光側の光無線伝送装置１へ送光する。

【００３７】ここで、各送光部１２２ａ～１２２ｄのＬＥＤ１２２２は、図５および図６に示したように、ＬＥＤ保持部１２３によって、同一平面Ａ上に、且つ、この平面Ａが受信側の光無線伝送装置１が備える光学部１３３の光軸ａに対し垂直になるように保持されている。さらに、個々のＬＥＤ１２２２は、ＬＥＤ保持部１２３によって、送光信号の光軸ｂが受信側の光無線伝送装置１が備える光学部１３３の主点ｏを通過するように調節されている。

【００３８】一方、受光側の光無線伝送装置１において、受光部１３２ａ～１３２ｄのそれぞれは、対向する送光部１２２ａ～１２２ｄ（送光側の光無線伝送装置１が備える送光部１２２ａ～１２２ｄ）よりの光信号を、光学部１３３を介して、自身が備える複数の受光素子１３２１により受光し、分割データに復調する。そして、復調した分割データを並列-直列変換部１３１へ送出する。

【００３９】ここで、受光部１３２ａ～１３２ｄ各々が備える複数の受光素子１３２１は、図５および図７に示したように、受光素子保持部１３４によって、光学部１３３の光軸ａに対して垂直であり且つ光学部１３３による受光スポットが形成される同一平面Ｂ上に、保持されている。そして、伝送距離Ｌの変更に対応できるようにするために、この平面Ｂ上に一列に配置している。各受光部１３２ａ～１３２ｄは、自身と対向する送光部１２２ａ～１２２ｄからの光信号を、この光信号の受光スポット位置にある受光素子１３２１で受光する。受光スポット位置にない受光素子１３２１は、加算部１３２３への接続がオフにされる。

【００４０】さて、並列-直列変換部１３１は、受光部１３２ａ～１３２ｄより並列出力された分割データを多

重化して通信データを復元し、復元した通信データを、伝送路ＩＦ部１１を介して伝送ケーブルへ送出する。

【００４１】以上の動作により、例えばビル間などの伝送ケーブルの敷設が困難な地点間での、通信データの伝送が実現される。

【００４２】以上、本発明の一実施形態について説明した。

【００４３】上述したように、本実施形態では、光信号送信部１２に、通信データを複数の分割データに分割してそれぞれを光信号に変換し、これらを互いに離間して配置された複数の送光部１２２ａ～１２２ｄから並列送光する処理を行なわせている。また、光信号受信部１３に、光学部１３３と、通信相手の光無線伝送装置１が備える複数の送光部１２２ａ～１２２ｄと１対１で対向する複数の受光部１３２ａ～１３２ｄとを用いて、通信相手の光無線伝送装置１より並列送光された光信号のそれぞれを受光して分割データに変換し、これらを多重して、通信データを復元する処理を行なわせている。ここで、複数の受光部１３２ａ～１３２ｄは、光学部１３３によって形成される、対向する送光部１２２ａ～１２２ｄの送光信号のスポットが、受光面上に位置するように配置されている。

【００４４】したがって、本実施形態によれば、波長分割多重方式や多値変調方式を用いなくても、送光部１２２ａ～１２２ｄが採用するＬＥＤ１２２２が持つ追随速度以上の高速な光無線伝送を実現できる。例えば、ＬＥＤ１２２２が持つ追随速度で実現可能な信号帯域を２５Ｍｂｐｓとした場合、本実施形態のように、１対の送光部および受信部をそれぞれ４つ設けることで、１００Ｍｂｐｓの通信データを無線伝送することが可能となる。これにより、レーザ装置に比べて安価で制御が簡単なＬＥＤを送光部に用いて、高速な光無線伝送システムを実現できる。

【００４５】また、本実施形態では、受光側において、送光側の送光部１２２ａ～１２２ｄから並列送光された光信号のそれぞれを、１系統の光学系（例えば凸レンズのみ）からなる光学部１３３を用いて、対向する受光部１２２ａ～１２２ｄで受光できるように集光している。このため、さらに安価な光無線伝送システムを実現できる。

【００４６】なお、送光部１２２ａ～１２２ｄは、発光素子としてコヒーレントでない光を送出するＬＥＤ１２２２を用いている。また、互いに離間して配置された複数の送光部１２２ａ～１２２ｄ各々のＬＥＤ１２２２を、送光信号の光軸ｂが受光側の光学部１３３の主点ｏを通過するように、つまり、送光信号の光軸ｂが互いに平行にならないようにしている。したがって、送信側の送光部１２２ａ～１２２ｄから並列送光された光信号のそれぞれを、１系統の光学系でなる光学部１３３で集光しても、光信号の干渉等による影響を小さくできる。

【００４７】また、本実施形態において、受光部１３２ａ～１３２ｄのそれぞれは、同一面上に配列された複数の受光素子１３２１と、受光素子１３２１毎に設けられた複数の選択部１３２２とを具備している。

【００４８】そして、選択部１３２２に、対応する受光素子１３２１について、受光信号に含まれる光信号と同じ周波数成分の、前記受光信号に含まれる前記光信号と異なる周波数成分に対する比率を検出させ、この比率が所定値未満ならば、受光素子１３２１が光信号を受信していないか、あるいは、太陽光等の外光による影響を受けていると判定し、この比率が前記所定値以上となるまでの間、対応する受光素子１３２１の加算部１３２３との接続をオフさせている。

【００４９】また、対応する受光素子１３２１のフロントエンドアンプ１３２１１よりの信号の直流成分を検出させ、この直流成分が所定値以上ならば、フロントエンドアンプ１３２１１が飽和状態になったものと判定し、この直流成分が前記所定値未満となるまでの間、対応する受光素子１３２１の加算部１３２３との接続をオフさせている。

【００５０】このようにすることで、複数の受光素子１３２１のうち、光信号の受光スポットが形成されている受光素子１３２１のみを加算部１３２３に接続することができるため、例えば、伝送距離Ｌが変更され、その結果、光学部１３３が形成する、送光部１２２ａ～１２２ｄの送光信号のスポット位置が変化した場合でも、この送光部１２２ａ～１２２ｄに対向する受光部１３２ａ～１３２ｄで受光することができる。したがって、送光部１２２ａ～１２２ｄや受光部１３２ａ～１３２ｄの位置調整を簡素化できる。また、このようにすることで、太陽光等の外光による影響を小さくできる。

【００５１】なお、本発明は上記の実施形態に限定されるものではなく、その要旨の範囲内で数々の変形が可能となる。

【００５２】例えば、上記の実施形態では、送光部１２２ａ～１２２ｄおよび受光部１３２ａ～１３２ｄをそれぞれ４つ設けているが、これに限定されず、送光部および受光部のそれぞれを複数設けたものであればよい。

【００５３】また、送光部１２２ａ～１２２ｄに用いる発光素子は、光無線に利用できる程度の放射束強度特性を持ち、且つ、コヒーレントでない光を送光するものであれば、ＬＥＤに限定されない。

【００５４】また、送光部１２２ａ～１２２ｄ各々が備える複数の受光素子１３２１は、図7に示すように、１列に配置したものに限られない。例えば、図８に示すように、送光部１２２ａ～１２２ｄ各々が備える複数の受光素子１３２１を、複数列に配置すれば、交点ｐを中心とした回転方向の受光スポット位置ずれを、受光素子保持部１３４で調節する必要がなくなる。このため、送光部１２２ａ～１２２ｄや受光部１３２ａ～１３２ｄの位

置調整をさらに簡素化できる。

【００５５】なお、受光部１３２ａ～１３２ｄのそれぞれに、受光素子１３２１を１つ設け、個々の受光素子１３２１を位置調整できるようにしてもかまわない。

【００５６】また、本実施形態において、双方向通信を行なわない場合は、送光側の光無線伝送装置１から光信号受信部１３を省略し、また、受光側の光無線伝送装置１から光信号送信部１２を省略してもよい。

【００５７】

【発明の効果】以上説明したように、本発明によれば、送光部が採用する発光素子が持つ追随速度以上の高速な光無線伝送を実現できる。

【図面の簡単な説明】

【図１】本発明の一実施形態が適用された光無線伝送システムの概略図である。

【図２】図１に示す送光部１２２ａ～１２２ｄの概略図である。

【図３】図１に示す受光部１３２ａ～１３２ｄの概略図である。

【図４】図３に示す選択部１３２２の概略図である。

【図５】図１に示す１対の光無線伝送装置１において、ＬＥＤ１２２２と、このＬＥＤ１２２２に対向する受光素子１３２１との相対的な位置関係を説明するための図である。

【図６】図２に示す送光部１２２ａ～１２２ｄ各々のＬＥＤ１２２２の配置例を示す図である。

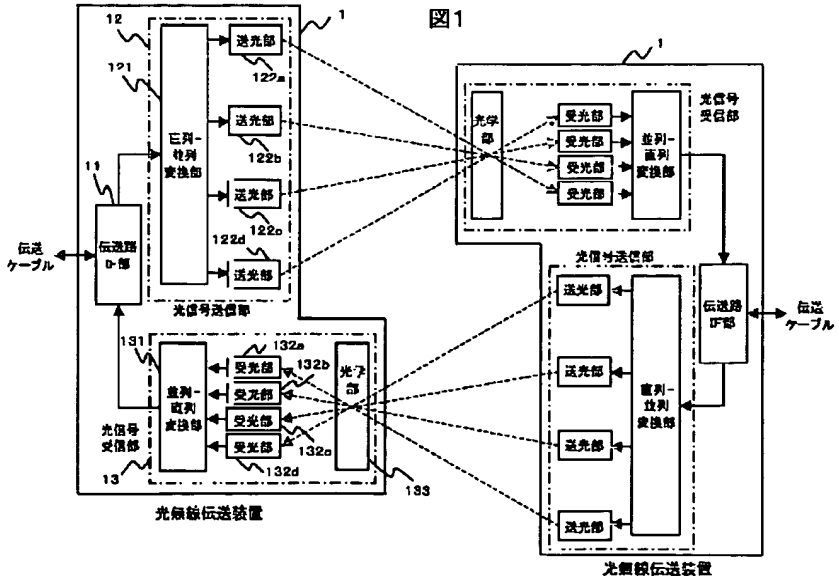
【図７】図３に示す受光部１３２ａ～１３２ｄ各々の複数の受光素子１３２１の配置例を示す図である。

【図８】図３に示す受光部１３２ａ～１３２ｄ各々の複数の受光素子１３２１の配置例（変形例）を示す図である。

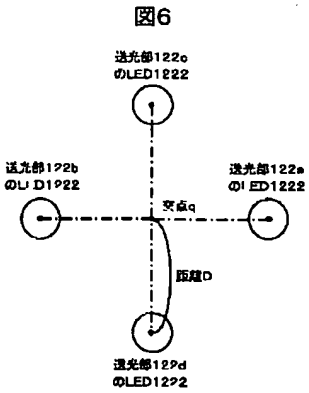
【符号の説明】

１…光無線伝送装置
１１…伝送路ＩＦ部
１２…光信号送信部
１３…光信号受信部
１２１…直列-並列変換部
１２２ａ～１２２ｄ…送光部
１２３…ＬＥＤ保持部
１３１…並列-直列変換部
１３２ａ～１３２ｄ…受光部
１３３…光学部
１３４…受光素子保持部
１２２１…変調部
１２２２…ＬＥＤ
１３２１…受光素子
１３２２…選択部
１３２３…加算部
１３２４…復調部
１３２１１…フロントエンドアンプ
１３２２１…直流成分検出器
１３２２２…直流カット用コンデンサ
１３２２３…ＢＰＦ
１３２２４、１３２２６…エンベロープ検波器
１３２２５…ＨＰＦ
１３２２７…比較器
１３２２８…ＳＷ制御部
１３２２９…ＳＷ

【図１】

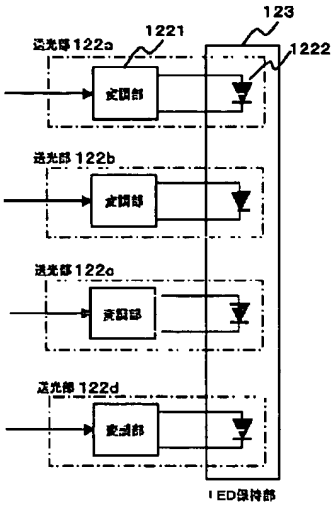


【図６】



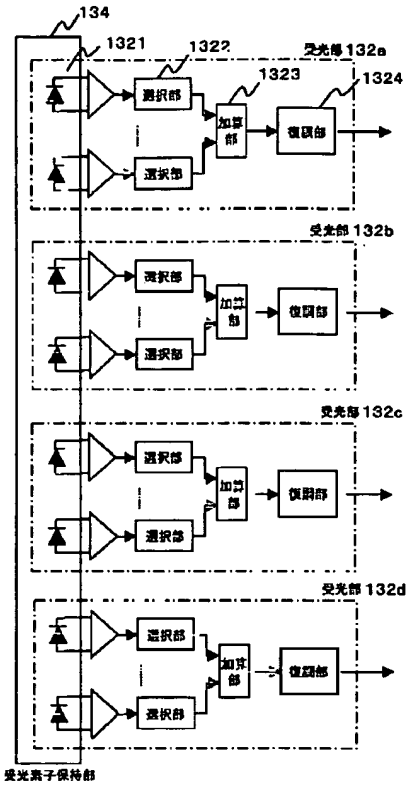
【図2】

図2



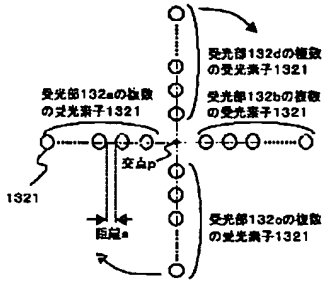
【図3】

図3



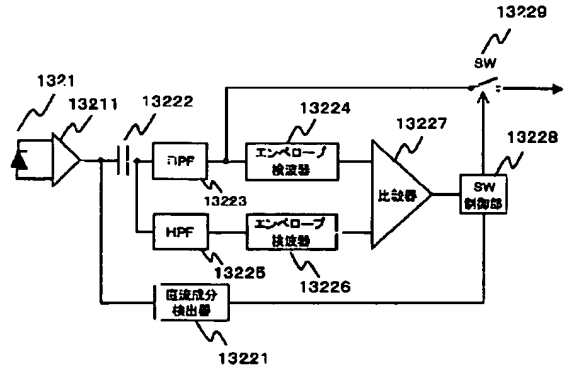
【図7】

図7



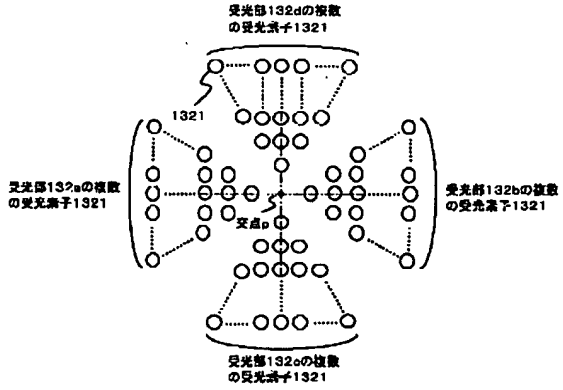
【図4】

図4



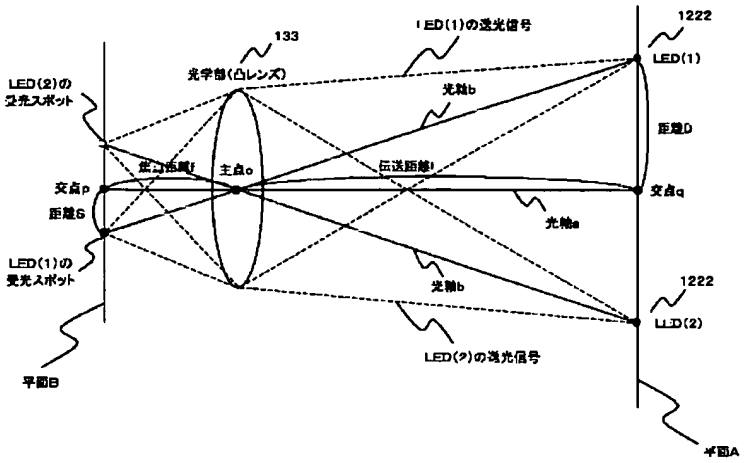
【図8】

図8



【図5】

図5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光学部(凸レンズ)
LED(1)の送光信号
1222
LED(1)
LED(2)の
受光スポット
光軸b
距離D
焦点距離f
主点o
伝送距離l
交点p
交点q
距離δ
光軸a
LED(1)の
受光スポット
光軸b
1222
LED(2)
LED(2)の送光信号
平面B
平面A